BY ORDER OF THE COMMANDER
AIR FORCE MATERIEL COMMAND

AFMC INSTRUCTION 21-103

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Maintenance

RELIABILITY-CENTERED MAINTENANCE (RCM) PROGRAMS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction implements AFPD 21-1, Managing Aerospace Equipment Maintenance. It provides guidance and procedures for establishing and monitoring preventive maintenance programs for aerospace equipment using RCM methodology.

SUMMARY OF REVISIONS

This revision aligns the instruction with AFPD 21-1.

Section A—General Information About the Program

1. Purpose. RCM programs ensure maintenance practices support the safest and most reliable operation of which the weapon system or equipment end item is capable. Through careful application of inspection and scheduled maintenance requirements, critical failures that can be anticipated will be minimized, and the highest probability of war-fighting capability will be achieved.

2. Program Definition. RCM analysis is used to develop scheduled inspection and maintenance requirements. The methodology involves the application of a logic process to a problem or failure mode identified by the Failure Modes, Effects and Criticality Analysis (FMECA) for new weapon systems and equipment end items or a combination of FMECA and field failure data for in-service weapon systems and equipment end items.

2.1. RCM analysis may be performed on a complete system or systems of a unit, including engines, or on individual items or tasks. Initially, an analysis will be performed on the complete system. In addition to periodic assessments, a subsystem or item analysis will be performed when dictated by modifications, maintenance performance data, or other valid indicators.

2.2. Analysis performed on new weapon systems and equipment end items will rely primarily on predicted failure modes and effects and, where feasible, equipment performance from similar weapon

systems and equipment end items. Analysis of in-service systems also relies on equipment performance data that includes materiel deficiency reporting and the maintenance data collection system. This data and the RCM analysis procedure are used to validate new inspection requirements generated by field input, operational experience, or modifications.

2.3. Developmental test and evaluation (DT&E) may be required to confirm or verify predicted or suspected failure modes, and provide an accurate focus for corrective actions. DT&E should be used in cases of substandard system performance when information is required in addition to the FMECA to investigate system, subsystem, assembly, or item parameters and characteristics and/or determine the quality of modifications or configurations.

3. Terms. Terms used in this instruction are listed in **Attachment 1**.

Section B—RCM Program Policy

4. Initial Requirements. The organization initiating new developments or modifications will develop the initial inspection and maintenance requirements based on an RCM analysis, unless a waiver has been granted by HQ USAF.

4.1. Periodic Assessment of Requirements. The system program director (SPD) will assess systems and equipment inspection requirements at least every 2 years. Note that for operational systems with extensive maintenance histories and structured programs to adjust maintenance tasks and intervals, the reassessment does not have to involve a specific RCM decision logic analysis. Reassessment should include failure and replacement data provided by the using commands. This may be done on a continuous basis if enough documented proof of this procedure is kept.

4.2. Documentation. The SPD is responsible for conducting the RCM analysis and using the results to establish the initial inspection and maintenance requirements. If the system is operational, the SPD will use field failure data and RCM principles to update inspection and maintenance requirements. The initial RCM analysis and all updating analyses must be documented to preserve the history and rationale for maintenance tasks. This documentation provides a basis from which to monitor the effectiveness of the inspection and maintenance program and to establish an audit trail of all RCM decisions.

4.3. Scope of RCM Analysis. The analysis program will consist of the following:

4.3.1. An FMECA on significant structures, systems, assemblies, and items. This includes analysis of hardware to find out what failure modes can occur on each item being analyzed and the effect each failure mode has on the item and the total system.

4.3.2. A decision logic procedure that guides the analyst through a screening process to establish maintenance requirements based on known or probable failure modes and effects. This decision logic is contained in MIL-STD-1843 (USAF) for weapon systems and equipment end items.

4.3.3. A frequency determination to select the best interval for each inspection and maintenance requirement.

4.3.4. A periodic assessment of individual inspection requirements and intervals to evaluate basic maintenance concepts (e.g., phase versus periodic) and program intervals (e.g., 50-hour phase versus 75- or 100-hour phase). Since most initial program intervals are conservative, an aggressive approach to extend basic program intervals is needed.

4.3.5. Documentation of these analyses and assessments to have consistently traceable maintenance requirements. Previous analyses should be compared to current analyses to establish new or refine existing maintenance requirements.

4.3.6. Potential Programmed Depot Maintenance (PDM) and Analytical Condition Inspection (ACI) Tasks. The RCM process will reveal potential PDM or ACI tasks. These tasks must be defined, justified, and submitted for approval by the Maintenance Requirements Review Board (MRRB).

Section C—RCM Program Procedures

5. Initial Analysis. The procedures for accomplishing an initial RCM analysis are as follows:

5.1. Identification of Items to be Analyzed. Identify the candidate items and structures to be analyzed. All functionally-significant items (FSI) and structurally-significant items (SSI) will be subjected to the analysis contained in MIL-STD-1843 (USAF).

5.2. Screen for FSI and SSI candidates including items identified from technical and engineering data and mission equipment lists. When preliminary or published work unit codes are available, each coded item is a candidate. When preliminary or published inspection and maintenance requirements manuals or inspection work cards are available, analyze all items listed as an FSI or SSI to validate, revise, or delete the maintenance requirements.

5.3. Include the completed lists of FSIs and SSIs as part of the index for the maintenance requirements analysis package for each program. This identifies those items that have been considered and where the analysis information is stored for future reference.

5.4. Failure Mode, Effects and Criticality Analysis (FMECA). RCM analysis stresses systematic and thorough analysis of significant failure modes and their effects on the safety and reliability of the system. Failure modes, item functions, and proposed inspection tasks will then be subjected to the decision logic tree process to establish the validity of each maintenance requirement. Documentation of the failure modes, effects and criticality analysis, the decision logic process, and the resulting tasks will provide consistent traceable maintenance requirements from which the maintenance program will be developed and refined. When changes are made in system design that may expand, remove, or reduce the impact of identified failure modes, the FMECA must be repeated for the redesigned or modified portions to ensure that all predictable failure modes in the new design or modification are considered. Note, however, that it is not necessary to completely reaccomplish the existing FMECA.

5.5. Consider all types of failure modes and effects that pertain to reliability, including deterioration and corrosion. Conduct a complete evaluation of each significant assembly or item with primary consideration for safety, operational readiness, mission reliability, and economy. Document failure modes, effects and criticality analysis on items that do not warrant maintenance requirements to preclude future duplication of effort.

5.6. In conducting the FMECA, overall mission effectiveness and the reliable operation of systems and subsystems must remain paramount. Consider the functional and operational relationships of the significant items and assemblies being analyzed to the overall system. Thus, the analysis should consider the effects of failure of items on higher or lower level assemblies, systems, or structures.

5.7. Failure modes, effects, and criticality are a primary design consideration to provide maximum safety and operational effectiveness. They are frequently the determining factor for redundancy of

equipment or functions and for safety or protective devices. Any subsequent analysis to determine inspection and maintenance requirements should consider these design considerations because they frequently reduce the impact of failures on safety or mission effectiveness.

5.8. The analyst will apply the logic process, establish the inspection or time change requirements and the frequency, recommend the equipment maintenance facility (field or depot), and provide documented rationale for each maintenance requirement. The initial analysis program will establish the inspection tasks. The information is kept for future reference on those items analyzed and determined to have no scheduled maintenance requirements.

5.9. Failure Analysis and Corrective Action Report (FACAR). This analysis identifies and documents the cause of a failure that has occurred during the design, fabrication, installation, or test phase of a program, and which may not have been addressed in the FMECA analysis. It also provides documentation and detailed analysis of the cause of identified failures and of corrective action taken by the contractor to restore the equipment to an operational status.

6. In-Service Systems Analysis. After a maintenance program is established, it must be continually evaluated and updated to maintain maximum efficiency and provide minimum impact on operational readiness. This process involves surveillance and resolution of day-to-day problems that impact inspection and maintenance requirements as well as a periodic assessment of the total overall program tasks and intervals. Incoming documentation that may affect RCM programs must be processed to ensure proper evaluation.

6.1. New Maintenance Tasks. Each reported problem or modification that may result in establishing new maintenance requirements will be analyzed using RCM. The analysis will use RCM principles to justify the resulting maintenance requirements. The analysis will be documented as well as the supporting engineering rationale.

6.2. Periodic Assessment. The SPD will conduct a periodic assessment (at least every 2 years) of all maintenance requirements to find out if current failure data and experience indicates the need to refine the tasks or intervals.

7. Decision Logic Process. Coupled with the failure modes, effects, and criticality analysis on significant items and assemblies or failure data and reports, the decision logic process prescribes the analytical procedures used to validate maintenance requirements.

7.1. RCM decision logic diagrams and procedures are found in MIL-STD-1843 (USAF). The diagrams contain the minimum essential decision logic requirements for application to RCM analysis. These procedures may be expanded to include additional considerations. Avoid considerations that would compromise safety, reliability, or economy.

7.2. The decision logic diagrams contain a series of questions that are answered either "yes" or "no." The answers, based on the FMECA or failure data and reports, determine whether or not an inspection task is required. Although some systems and equipment will not have an initial RCM analysis baseline, all changes to existing inspection and maintenance requirements will be validated by using RCM principles. This analysis ensures a positive approach to establishing and refining maintenance requirements.

8. Interval Determination. The RCM decision logic process or the FMECA does not consider the frequency of inspections. The decision logic process must be supplemented with inspection interval analysis to provide an effective inspection program. Since the frequency greatly determines the amount of work expended in a maintenance program, place as much emphasis on this determination as on the selection process. An initial interval must be established for all new inspections and the interval for an established inspection will require review and analysis for possible refinement.

9. Responsibilities. This instruction assigns the following responsibilities to the SPD:

9.1. Conducts, documents, and implements the results of RCM analysis according to MIL-STD-1843 (USAF).

9.2. Uses the Logistics Support Analysis (LSA) (MIL-STD-1388), FMECA (MIL-STD-1629A), reliability predictions, system safety hazard analyses, operational studies, engineering analysis and tradeoff studies, and past performance studies to support the RCM analysis.

9.3. Uses the results of the RCM analysis to determine preventive maintenance requirements.

9.4. Summarizes results of RCM programs and submits for air logistics center (ALC) and major command (MAJCOM) MRRB review (as part of the PDM package if one exists).

9.5. Analyzes all proposed changes/refinements to maintenance requirements using data from all available sources including AFTO Forms 22, **Technical Order System Publication Improvement Report and Reply**, and interim operational and safety supplements that are a result of mishaps.

9.6. Evaluates and analyzes all recommended refinements in the established maintenance program by using the principles of RCM.

9.7. Maintains RCM documentation.

9.8. Coordinate proposed new maintenance requirements involving engines and time change items with the item manager before publication.

9.9. Coordinates any significant changes in organization workload with the using command before publishing them in technical order manuals.

9.10. Periodically assesses preventive maintenance requirements, program intervals, and special inspections by conducting reviews and requesting assistance from the item manager.

9.11. Initiates periodic joint SPD, item manager, and using command Program Review Conferences.

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

Terms

Analytical Condition Inspection (ACI)—The systematic disassembly and inspection of a representative sample of aircraft to find hidden defects, deteriorating conditions, corrosion, fatigue, overstress and other deficiencies in the aircraft structure or systems. ACIs are normally over and above those inspections specified in the technical order or PDM work specifications.

Failure Modes, Effects and Criticality Analysis (FMECA)(MIL-STD-1629A)—An analysis performed to identify the predicted failure modes of an item and the effect each failure mode has upon the item, system, and end item operation.

Functionally-Significant Items (FSI)—Those items other than structures judged to be relatively important from a safety, reliability or economic standpoint.

Logistic Support Analysis (LSA) (MIL-STD-1388)—The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the system engineering and design process, to assist in complying with supportability and other Integrated Logistics Support objectives.

Maintenance Requirements Review Board (MRRB)—A panel that assures all valid depot level maintenance requirements are evaluated and scheduled for appropriate fiscal year accomplishment. The process for this assurance involves an annual on-site review of the proposed maintenance program for each weapon system to assess the depot interval, the time in depot (flow days), and the validity of each detailed task in the work package. The panel is comprised of using command representatives and AFMC engineering, funding and aircraft maintenance experts. Changes to an approved maintenance program must be submitted with complete justification to the MRRB prior to incorporation in the work package and submission for funding. MRRBs are convened at the ALC and MAJCOM levels.

Maintenance Steering Group Document Number Two (MSG-2)—This document describes an analytical process used by the airline industry to establish or update scheduled maintenance requirements on a variety of commercial aircraft.

Maintenance Steering Group Document Number Three (MSG-3)—This document identifies an improved decision logic over the MSG-2 logic in that it provides a more rational procedure for task definitions and a linear progression through the decision logic. It also expands the logic to include propulsion systems.

Reliability-Centered Maintenance (RCM) (MIL-STD-1843 {USAF})—A maintenance concept that has the objective of achieving the inherent, or designed-in, reliability of a system. The concept is a derivative of the airline/manufacture maintenance planning documents, MSG-2 and MSG-3, published under the auspices of the Air Transport Association.

RCM Analysis (MIL-STD-1843 {USAF})—A structured approach to the development of an RCM concept for a system or end item. It uses FMECA and integrity program outputs and MSG-2/MSG-3 logic to identify maintenance tasks which must be performed on a scheduled basis to ensure the attainment of inherent reliability.

Structurally-Significant Item (SSI)—A structural detail, structural element, or structural assembly that

is judged significant because the consequences of its failure could be a reduction in aircraft, engine, or equipment residual strength or function to the extent that safety or mission is adversely impacted